58. (New) The conduit of claim 54, wherein said reactive resin is poly(vinyl chloride-co-vinyl acetate-co-2-hydroxypropyl acrylate).

59. (New) The conduit of claim 54, wherein said thermoplastic material is PVC.

60. (New) The conduit of claim 54, wherein said PVC has a tensile strength of between 5,000 to 10,000 psi.

REMARKS

The Applicant has cancelled claims 28-37 and 39-46 and added new claims 47-60 to more clearly define the invention. The Applicant respectfully submits that, as the new claims are simply clarifications of cancelled claims, a new prior art search will not be required. No new matter has been added.

The Examiner has maintained her rejection of claims 28-37, 39-43, and 45-46 as unpatentable over O'ffill in view of Rosemund et al and Muller et al. In addition, the Examiner maintains her rejection of claims 28 and 44 as unpatentable over O'ffill in view of Rosemund et al and Muller et al, further in view of Ranney et al.

The Examiner states that O'ffill shows a PVC liner and a resinous interlayer between the liner and the pipe or other structure. However, the Applicant submits that O'ffill teaches the use of an interlayer that bonds only to the pipe but not to the liner (see Col. 4, lines 26-47). "It is desired that the carrier cure to form a strong bond with the surface of the substrate but not with the back side surface of the flexible liner so that the only mechanism retaining the flexible liner against the carrier is the mechanical lock that is formed between the OPM's and the carrier" (see

O'ffill Col. 7, lines 13-34). O'ffill goes on to explain that, by not bonding to the flexible liner, the flexible liner can remain flexible with respect to the adjacent wall surface, thereby enabling the liner to better protect against fluid or gas leakage.

The Examiner further states, that "[b]oth Applicant and O'ffill are lining a curved structure with a PVC inner layer in order to strengthen it". However, the Applicant respectfully submits that O'ffill makes no reference to means for strengthening a curved structure. Furthermore, there is no suggestion that the method of O'ffill contributes to the tensile, compressive, or flexural strength of the host structure. The Applicant further submits that it is well known in the art that the method of O'ffill cannot be used to repair pipes or culverts that have lost part of their steel reinforcement due to corrosion, and thus have lost their load bearing capacity. In such cases, new steel reinforcement must be added to the structure before lining with the method of O'ffill.

At Column 7, lines 18-24, O'ffill states that "[t]he formation of a bond between the carrier and the flexible liner back side surface is not desired so that the flexible liner can remain flexible with respect to and independent from the adjacent wall surface. This eliminates the possibility of the flexible liner cracking or tearing as a result of cracks that develop in the substrate and that are transmitted from the wall portion to the carrier." In other words, by keeping the flexible liner independent from the carrier, loads cannot be transmitted from the host pipe through the carrier to the PVC liner. This in turn protects the liner from cracking or tearing.

The applicant submits that the present application teaches the exact opposite of O'ffill. The PVC liner is fully and

continuously bonded to the thermosetting material (i.e., the carrier), which in turn is bonded to the substrate forming an integrated composite. In this way, the stresses experienced by the structure due to externally and internally applied loads (e.g., earth loads, live loads, hydrostatic pressure from ground water, etc.) are transmitted and transferred to the PVC via the thermosetting material. When stresses are transferred from the corroded host structure to the PVC liner, the host structure is effectively reinforced and the load bearing capacity of the original structure is improved. The amount of stress transferred from the host structure to the PVC liner depend mainly on the material properties of the PVC liner and thermosetting material, and on the thickness of each of these sections. The most relevant material properties are: (1) The modulus of rigidity and strength of the PVC liner, (2) the shear modulus of rigidity, and shear strength of the thermosetting material, and (3) the normal and shear bond strengths between the thermosetting material and the host structure, and between the thermosetting material and the PVC liner. As is discussed in greater detail below, the treated PVC liner of the present invention is bonded to the thermosetting material by means of strong covalent bonds, rather than the mechanical locking and adhesion of Muller and O'ffill. The continuous covalent bonding of the present invention provides superior transfer of stresses from the host structure to the PVC liner, resulting in a greatly reinforced and strengthened structure.

In particular, the flexural stiffness and strength of the host structure are significantly improved when the method described by the Applicant is applied on faces of the host structure that are under tension as a result of an applied bending moment. This circumstance occurs at the crown of all buried pipes and culverts. In turn, the crown is the part of a concrete pipe or culvert that is most susceptible

to hydrogen sulfide induced corrosion, and it is the part that most frequently requires structural repair. Under the above-mentioned circumstances, the PVC sheet, via the thermosetting material, behaves as tensile steel reinforcement.

The Applicant has proven via testing that the application of the method of the present application can increase the strength of a corroded host pipe with severe structural damage (i.e., missing steel reinforcement) by 300 to 400 percent over the original design strength of the un-corroded pipe. It is important to note that the present invention is able to achieve this strengthening without significantly changing the hydraulic diameter of the host pipe.

Therefore, the Applicant submits that, although O'ffill discloses a means for surfacing or rehabilitating pipelines, it does not disclose a means for strengthening or reinforcing the host structure.

The Examiner states that Muller discloses presoaking of a liner with a resin before it is placed in a pipe. Muller discloses a liner comprising inner and outer fiber fleece layers separated by a fluid impermeable barrier layer. The inner and outer fiber fleece layers are bonded to the barrier layer by means of heat to form a unit (see Muller Col. 2, lines 14-26, and Col. 3, lines 15-20). The bond between the fleece layers and the barrier is not a covalent bond, but a heat fusion bond, which is a mechanical bond arising from the interpenetration of the materials. In another step, the outer fleece layer is "soaked" with a plastic resin, which in turn is used to adhere the liner to the substrate. This soaking technique is well known in the art.

Applicant submits that the soaking step of Muller does not disclose the impregnation of the PVC liner, as described in the present application. The method of the present application involves impregnating an activator liquid solution into the rigid PVC liner. The activator solution contains solvents and a polymer with free hydroxyl groups that become embedded inside the rigid PVC liner. The polymer with free hydroxyl groups remains in solution inside the PVC liner by virtue of chemical bonds between the polymer and the PVC liner. The activator treatment ends after all the solvents have evaporated out of the PVC liner. The treated PVC sheet is then contacted with the just mixed two-component thermosetting material, which is in liquid form before curing. Some of the free isocyanate groups of the thermosetting material react with the hydroxyl groups embedded in the treated PVC liner, producing a urethane bond. That is, the treated PVC liner is continuously bonded to the thermosetting material by means of strong covalent bonds, rather than the mechanical locking and adhesion of Muller and O'ffill. The continuous covalent bonding of the present invention provides superior transfer of stresses from the host structure to the PVC liner, effectively reinforcing and strengthening the host structure.

Further, the Applicant submits that Muller does not disclose means for strengthening a pipeline. In fact, Muller implicitly claims the opposite when it is stated that "the plastic resin of the outer layer does form an adhesive bond with the old pipe so that the old pipe and the lining tube form a unit whose statics are determined largely by the old pipe" (see Muller Col. 2, lines 41-48, see also Col. 3, lines 36-41). This statement indicates that the lining tube does very little to improve the load bearing capacity of the old pipe, in contrast to the method of the present invention.

The Examiner states that Rosemund et al deals with polyurethane foams that may be used to bond mineral containing substrates to PVC and that the foams contain catalysts, surfactants, blowing agents and curing agents. The Applicant submits that Rosemund teaches heating the surface of a thermoplastic polyurethane foam in solid state above its melting or fusion temperature, and contacting the melted or fused surface with a substrate to form a bond. The Applicant submits that no covalent chemical bonds are formed between the substrate and the polyurethane foam in the method of Rosemund. As is described above, the method of the present application does not use heat fusion for bond formation between the PVC liner and the thermosetting material. In fact, the use of such a method would be impossible since the thermosetting material is a thermo*set* rather than a thermo*plastic* material (i.e., it does not have a melting or fusion temperature). Instead, the bond is produced by strong covalent chemical bonds (i.e., urethane groups). These covalent bonds are the product of a reaction between the free hydroxyl functional groups embedded in the treated PVC liner, and free isocyanate groups of, for example, a recently mixed polyurethane foam in liquid form. After the final cure, the resulting bond strength between the thermosetting material and the PVC liner is about two orders of magnitude greater than those disclosed in Tables IX and X of Rosemund.

In summary, the Applicant submits that none of the references cited by the Examiner, alone or in combination, disclose means for strengthening or reinforcing a host structure. The Applicant further submits that none of the references cited by the Examiner discloses the formation of covalent bonds between the thermosetting material and the thermoplastic liner. The strength of the covalent bonds permits the transfer of stresses from the host structure to

the thermoplastic liner, which is essential for reinforcing the host structure.

In view of the foregoing amendments and remarks, favorable reconsideration of the Application is respectfully solicited.

Respectfully submitted,

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I hereby certify that this correspondence is being hand carried to the U.S. Patent and Trademark Office on 12-21-2001

MATTHEW A. PEQUIGNOT REG. 43,851 DATE